REPORT OF S[illegible]RY OF TREASURY

3

ON THE CO[illegible]T SURVEY.

TREASURY DEPARTMENT. *Feb.* 15, 1851.

:R: I have the honor to transmit a report in reply ie resolution of the Senate of the United States lst December last. The resolution is as follows:

Resolved, That the Secretary of the Navy be directed port to the Senate what advantages to the public ser- would be derived from transferring the survey of the : from the Treasury to the Navy Department, as re- nended in his report accompanying the President's an- message; and what additional legislation, if any, d be necessary; and that the Secretary of the Treasury nunicate to the Senate, why, in his opinion, the sur- of the coast should not be transferred from the admin- ion of the Treasury Department."

iave given the subject due consideration. and, after :cting all the facts relating to it, come to the full iction that to transfer the work to the Navy De- ment would be to destroy it, by disorganizing the ent admirably devised system, which, for efficien- ind economy, can scarcely be improved; and :h, in its results, has never been surpassed.

his organization combines all the efficiency which be derived from the army, the navy, and the sci- : of the country, assigning to each its appropriate re of action.

nder this organization the most rigid control is cised over the expenditures, and a greater amount ork produced, in proportion to the cost, than in other operation of the same kind ever under- n.

nder this organization three-eighths of the coast of Atlantic and Gulf of Mexico have been surveyed, , at the present rate of progress, the remainder be completed within twelve to fifteen years, while survey of the Pacific coast is rapidly advancing.

. similar organization cannot exist under either War or Navy Departments. The officers of the ner cannot be made to co-operate with those of latter, except under a neutral department.

ll the experience of the past years of the Superin- dent and his assistants would be lost by the pro- ed transfer, and the completion of the work would indefinitely postponed.

he work being one of commerce, essentially be- gs to this Department; and its transfer, without approval of the Department, would imply a cen- e of its administration. which is wholly unjustified the history of the survey.

. I propose in the following report to show, first, general adequacy of existing laws and regulations the conduct of the coast survey.

I shall give an account of the law of 1807, direct- a geodetic survey of the coast; of the repeal of s law in 1819, and the consequent destruction of organization; of the re-enactment in 1832 of the ne law, with extended powers for its execution.

I shall also state the plan of organization adopted der legislative authority in 1843, providing for the de of executing the work and its principal arrange- nts under the laws of 1832 and 1807; of the regula- n of the Treasury Department (of 1844) for exe- ting this plan; and the yearly directions issued for details of the work under the approval of this De- rtment.

. I shall next show that the efficiency and harmo- of the organization, containing civilians, army and vy officers, have been due to their union under a civil department, and is impracticable under a military one.

That as many officers of the army and navy as could be obtained have been employed, and that a nucleus of civilians is indispensable.

That the Navy Department is not now able to furnish the limited number of officers necessary for the hydrography.

I am compelled in passing to notice the fact, that the facilities formerly afforded this work, under the law, by the Navy Department, have recently been much abridged, and to suggest a remedy.

3. The satisfactory progress of the survey is next shown by the extent of coast already completed, and in comparison with other works of the same kind.

That a corps, having other and permanent duties, will complete such a work rapidly and efficiently, is contrary to all experience.

4. I shall next show the high estimation in which the present administration of the work is held by distinguished scientific societies and individuals, and by the commercial community. The testimonies to its merits by such men as Arago, Humboldt, and Schumacher, must be regarded as conclusive.

5. I shall next establish the fact, that no country has yet made a survey of its coast, including land and water, by the employment of its navy alone. That no merely nautical survey can meet the wants of commerce or the requirements of science; that the present methods in use in the different departments of our survey are those universally considered the best, and that the adoption of any other methods would lead to a waste of time and money.

6. It will next be shown, by actual experience in the coast survey itself, that the work, as at present organized, cannot be transferred to the Navy Department.

The attempt to survey the coast by naval officers alone, between 1819 and 1832, was an entire failure. The charts produced were pronounced by the Secretary of the Navy (Hon. Samuel L. Southard) to be "expensive, unsafe, and in many instances, useless and pernicious;" and he recommended a recurrence to the law of 1807.

No attainment has been since made by officers of the navy in the coast survey to qualify them better for the charge of the whole work; their experience has been confined to the hydrography, while the land-work constitutes four-fifths of the whole. The navy would be disorganized by converting its officers into topographical surveyors.

7. An examination is next made of the cost of this survey as compared with foreign ones. and the great relative economy of this work is established. The economy of its topography, as compared with the survey of the public lands is also shown.

8. By examining the relative cost of nautical surveys made under the Navy Department, with the complete ones made in the coast survey, the very great expense of the former is found.

I next proceed to show that scientific operations, conducted by the Navy Department, are more expensive than those of the coast survey.

I show the importance to economy of direct appropriations, instead of using large contingent funds for the execution of works.

9. The superior economy of this Department is

shown by the smaller number of officers employed [illegible] each party in the coast survey, in comparison with the parties of the nautical surveys made under the direction of the Navy Department.

10. The greater economy in repairs of vessels by this Department is shown.

11. It is next proved, that the objection sometimes urged against the economy of the coast survey on the score of the extensive work is ill-founded; the cost of the whole survey of the coast is thereby much diminished, and the time of its execution greatly abridged.

A change in the present organization would, if productive of no other evil, be attended with loss of time and useless expenditure.

All the experience which has been acquired by the persons engaged would be lost to the work.

12. Throwing out of view the instruction afforded to the officers of the navy in the hydrography of the coast survey, it is shown that efficiency and economy would be consulted by connecting a certain number of naval officers permanently with the work, and dispensing with the use of the sailors of the navy.

13. The results of the coast survey are next shown by the statistics of the different parts of it, and by reference to reports heretofore presented to Congress, by an enumeration of its discoveries, of its hydrographic and other improvements, of its maps and charts published and in course of engraving and drawing.

The large amount of useful matter collected, and the activity in its publication, is thus proved, and the improvements introduced attest the progressive character of the work as at present administered.

14. I next meet the objection sometimes urged against the survey on the score of the changes in the coast, showing that in those parts of the coast where this is the case the fixed marks afforded by the trigonometrical survey are absolutely necessary.

15. I next show that the several parts of the survey form a harmonious whole—the separation of which would be the destruction of the work.

16. The injury resulting to the navy from the employment of its sailors ashore, and the inapplicability of persons of this kind to the work, is shown.

17. I consider that the proposition to transfer the coast survey to the navy is unfortunate for the navy itself, since it implies that there are more persons under that department than are needed.

18. Experience shows, contrary to what might be supposed, that hydrography, at a distance from the shore, would not be increased by the transfer of the work.

The distance to which the work is carried inland is shown to be necessary for defence and useful for many purposes of navigation, and to promote accuracy and rapidity in the operations.

Its extension to embrace the Gulf Stream is necessary to the completeness of the hydrography, that current being the characteristic of our Atlantic navigation.

19. It is sometimes supposed that great facilities have been derived from the coast survey from the Navy Department by the transfer of vessels. The contrary is shown, and the fact that the Navy Department has no vessels adapted to surveying purposes.

20. I prove that the employment of officers of the navy in the land-work of the coast survey would be calling upon the sailor to perform operations entirely foreign to his education, his habits, and his profession.

21. In conclusion, I show that if qualification alone were made the test of claims to a work, the greatest [illegible]fusion and warmest conflicts would occur between different branches of the Government.

1. The first law, providing a survey of the coast of the United States, was that of 1807. It authorized, in the view of the President (Mr. Jefferson) and of the Secretary of the Treasury (Mr. Gallatin,) "a survey of the whole coast of the said States, together with the adjacent shoals and soundings;" the word coast is used as synonimous with the land which constitutes it, and the water is distinctly and separately referred to. The survey was to combine work on the land and on the water. The plan of a complete geodetic survey, as now understood, was sketched by Mr. Gallatin in his circular letter inviting plans for executing the work under the law, and so completely that the reply of Mr. Hassler extends and amplifies the ideas on which the survey are based, rather than suggests new ones.

The positions of a few chief points were to be determined astronomically, and these were to be connected by "a trigonometrical survey," and upon the basis furnished by these geodetic determinations, nautical surveys of the shoals and soundings of the coast were to be made. The distracted state of our foreign relations caused the execution of this law to be postponed until 1816, when Mr. Hassler, having returned from Europe, whither he had been sent to purchase instruments, took the field to begin the work.

In his plan of operations, Mr. Hassler suggests the employment, as his assistants, of officers from the army, for the geodetic work, and of well-informed officers, brought up in the Military Academy, and naval officers, in the nautical part of the survey. Also, the establishment of two observatories—one in Maine and one in Louisiana—to be connected with the survey of the coast. The whole work was placed by the President, from its beginning, in the Treasury Department, and the first arrangements for field-work, in 1816, were made by the Secretary of the Treasury.

The original law did not refer to the employment of military or naval officers, which was a suggestion of Mr. Hassler, founded on the idea of a saving in direct appropriation. and of the use of the work as a school of practice for the officers.

The practical operation of a system is the only conclusive test of its merit; and the difficulties which beset the organization (relying upon exclusive military aid) were such, that when in 1832 the survey was recommenced, we find Mr. Hassler urging upon the Treasury Department, under which it was again placed, the appointment of several civilians as his assistants, besides officers of the army and navy. The general idea was to obtain assistants from any quarter where the necessary talents and ability might exist—a condition which has been pronounced by high, practical authority, (Professor Schumacher, of Altona,) to be indispensable to success in such a work.

In April, 1818, the act of 1807 was repealed, so far as it authorized the employment of other persons than those belonging to the army or navy of the United States. The insufficient character of the results, and the wasteful expenditure in obtaining them, will be proven in another part of this report.

At the earnest and repeated recommendation of Samuel L. Southard, the Secretary of the Navy, the former organization was revived—the survey being however placed, as before, under the Treasury Department. This was done by the act of July 10, 1832, reviving the law of 1807, with extended powers to the President for the execution of the survey. Its provisions are as follows:

"An act to carry into effect the act to provide for a survey

of the coast of the United States." (See vol. 4, p. 79, act of 10th February, 1807.)

"Sec. 1. *Be it enacted*, &c. That, for carrying into effect the act, entitled 'An act to provide for surveying the coast of the United States,' approved on the 10th day of February, 1807, there shall be and hereby is appropriated a sum, not exceeding twenty thousand dollars, to be paid out of any money in the Treasury not otherwise appropriated; and the said act is hereby revived, and shall be deemed to provide for the coast of Florida, in the same manner as if the same had been named therein.

"Sec. 2. That the President of the United States be and he is hereby authorized, in and about the execution of the said act, to use all maps, charts, books, instruments, and apparatus, which now or hereafter may belong to the United States, and employ all persons in the land and naval service of the United States, and such astronomers and other persons as he shall deem proper: *Provided*, That nothing in this act, or the act hereby revived, shall be construed to authorize the construction or maintenance of a permanent astronomical observatory."

The act of 1843, without repealing any previous law, directs the execution of the survey according to a plan to be prepared by a board consisting of three civilians and six officers of the army and navy, and that the plan of this board "shall cause to be employed as many officers of the army and navy of the United States as will be compatible with the successful prosecution of the work—the officers of the navy to be employed in the hydrographical parts, and the officers of the army on the topographical parts, of the work."

The act of March 3, 1843, appropriates for the fiscal year ending the 30th June, 1844, as follows:

"For survey of the coast of the United States, including compensation of Superintendent and assistants, one hundred thousand dollars: *Provided*, That this and all other appropriations hereafter to be made for this work, shall, until otherwise provided by law, be expended in accordance with a plan reorganizing the mode of executing the survey, to be submitted to the President of the United States by a board of officers which shall be organized by him, to consist of the present Superintendent, his two principal assistants, and the two naval officers now in charge of the hydrographical parties, and four from among the principal officers of the corps of Topographical Engineers; none of whom shall receive any additional compensation whatever for this service, and who shall sit as soon as organized. And the President of the United States shall adopt and carry into effect the plan of said board, as agreed to by a majority of the members; and the plan of said board shall cause to be employed as many officers of the army and navy of the United States as will be compatible with the successful prosecution of the work—the officers of the navy to be employed in the hydrographical parts, and the officers of the army on the topographical parts of the work; and no officer of the army or navy shall hereafter receive any extra pay out of this or any future appropriations for surveys."

This plan directs not only the general principles, but the mode of executing the work; provides for the main, secondary, and tertiary triangulation; for the topography and for the soundings; for the measurement of a base; for the astronomical determinations; for the publication af results; for the organization of the parties necessary to execute the parts of the survey; the division of the land parties between civilians and officers of the army; the detail of chiefs of hydrographic parties from the navy, and mode of organizing their parties; the arrangement of the office and its charge; the preparation cf journals and duplicates, and their delivery and preservation; the order of succession of the parts of the work, placing the triangulation first, and the topography and soundings last; the astronomical and magnetic observations; the disbursements; the relieving of the officers of the army and navy; the arrangement of duties in the field; the suspension of officers; the compensation, supply of vacancies, proportion of sail and steam vessels for the hydrography; the placing of the survey as a work of commerce, and as employing officers of the army and navy, and civilians, under the Treasury Department.

This plan having been approved by the President, leaves to the Treasury Department the executive details of the work only. The plan embodied all the experience obtained at the time, and was formed by a board constituted in the most unexceptionable manner.

That board, in which the military officers were double the civilians in number, recommended the placing of the work under the Treasury Department; such was the deliberate judgment of Colonel Kearney, Captain Swift, and Lieutenant Colonel Hughes, of the Topographical Engineers, and of Captain Gedney and Lieutenant Blake of the Navy.

The regulations of the Treasury Department, for the general direction of the work, under the laws of 1807 and 1832, and the plan of reorganization, approved by the Hon. John. C. Spencer in 1844, have been found to answer all the purposes of efficiency in its executing, and are at this time the regulations under which the survey, in its present extended form, is carried on.

The practical operation of these regulations has proved their excellence in a trial of seven years.

Every year the Superintendent submits to the examination of the Secretary of the Treasury, the details of execution of the work of the year, comprising directions to all the persons employed. These directions, after approval, are committed to the execution of the Superintendent, who is directly responsible to the Department.

I subjoin a copy of these general regulations, and of the directions for the past year.

The expenditures are on the usual footing of bureaus in the Treasury Department. The officers are, by the plan of organization, disbursing agents for their parties. Their estimates must be approved by the Superintendent. The general disbursing agent first audits their accounts, and submits them to an administrative examination by the Superintendent, such as is made by the chiefs of the Engineer bureau and others in the army, and transmits the whole, quarterly, to the First Auditor, by whom they are examined and passed to the First Comptroller. Under this system, not a cent has been lost in disbursing for the coast survey, from the time of its organization to the present day.

Beginning with the law passing through the plan of organization by the combined board; the regulations by the Treasury Department; the directions by the same; the execution by competent, scientific men; the effective control, both general and fiscal, of this Department; it may be affirmed that there is no other work under the direction of the Government which has been so thoroughly legislated for and regulated as this.

The experience of the Department is all favorable to the harmony, efficiency, and economy, of this system; and no theoretical reasons, however plausible, should, in my opinion, be suffered to weigh against practical experience so ample and conclusive.

2. Whatever of efficiency is to be had from the science of the country, and it cannot be contended that science can lend nothing to a work pre-eminently and confessedly one of high science, the coast survey now has, or can have, from its present organization. Whatever of efficiency the staff or line officers of the

army, from their professional or preparatory pursuits, or studies, can lend to it, the coast survey can now have. Whatever of efficiency the naval officers can bring to the work, it can now have.

The only question at the outset of such a work would be, Is such a combination possible? Can these three elements be made to act in harmony? If they can, there could be no doubt that such a combined organization would yield the total efficiency of each in their union.

This question experiment has fully answered, and in the affirmative. The harmony between the civilians and army and navy officers has been complete. The question of rank, and others which would grow up under other than a civil head, do not here obtain. No courts martial or courts of inquiry have ever taken place in the coast survey, nor has it been necessary to report for discipline, or even for public censure, any of the officers of either service, in consequence of difficulties growing out of the union of the three.

The calls upon the services of army and navy officers appear to be desirable up to the point where the army or navy must be increased, to furnish officers, or where the work would suffer in efficiency. The second point has not been reached, since there are calls upon both branches of service for officers from this Department remaining yet unanswered.

If the work were left without a nucleus of civilians, any calls for the services of military or naval officers by war, or anticipation of war, would destroy the work for the time, and would produce not only delay, but useless expenditure and even entire disorganization.

The organization of the naval parties subjects them exclusively to naval control, and the operation of naval rules, regulations, and usages; as, in the cruising vessels of the navy, the discipline depends upon the commanders of the vessels. The instructions of the Superintendent are given to the chief of the hydrographic party, and to him only.

So in the army parties, as far as practicable, the organization has been made a military one. On first coming upon the survey, the line officers generally, and very properly, desire to be attached to some party where they may become versed in the practical operations of the survey, and this leads, in those cases, to a temporary connexion with a civil party; but these are not the normal cases, but exceptions.

The plan of reorganization, under the law of 1832, was directed to provide that as many officers of the army and navy as was compatible with the successful prosecution of the work, should be employed. The land-work was accordingly to be executed by civilians and officers of the army, in as nearly equal number of parties as possible, and the hydrography by officers of the navy.

If this plan has, in good faith, been carried out, then all has been done which is practicable. How stands the fact in the case? That this Department has always employed as many officers of the army and navy as could be obtained; that the number of officers of the army on the work when the Mexican war began was fourteen; that the number of naval parties has been increased from two, in 1843, to nine, in 1850; that application after application has been made to the War Department for the detail of army officers, both of the staff and line; that the difficulty has been to obtain the number of naval officers required to furnish the hydrographic parties; that the obstacles to the detail of line officers of the army have been removed, and there are now two staff and five line officers attached to the survey, and that there are two outstanding applications for the services of other officers, which it is expected will receive favorable consideration; that application was made for navy officers for the hydrography of the coast of Texas, at the close of October; that, after the detail of one passed midshipman, the Navy Department stated that others junior to him could not be detailed, though he was near the head of the list of passed midshipmen; that this officer himself was relieved without notice to this Department, and that, up to this date, the vacancies in that hydrographic party remain unfilled, and the schooner Morris, which has been repaired at the expense of the coast survey, is still without her complement of officers—the only passed midshipman attached to her has been ordered from one of the parties on hydrographic duty at the office; that the steamer Jefferson, which it is so important to send at the earliest moment practicable to the Pacific, is still without her complement of officers, though applications from this Department have been made in December and repeated in January.

It is not the desire of this Department to interfere with the operations of co-ordinate branches of the Government, but when it is obvious that duties, considered by the Navy Department as taking precedence of the coast survey, are allowed to interfere with details for this service, or that the number of the navy officers is really too small to permit such details, it is necessary frankly to state this conclusive argument against a transfer of this work to the Navy Department.

While the utmost harmony has thus reigned among the different branches of the service upon the work, it is but proper to state that the facilities granted ordinarily by the Navy Department, and which had passed into usage, were one by one removed, beginning with the autumn of 1849, and the position of the naval officers on the survey made materially worse than they had formerly been. Instead of permitting officers to remain on the survey for a period of years, they were detached without regard to their employment, frequently in the midst of surveying operations. Instead of being allowed to complete the hydrography in the office, half of each party was regularly detached from the survey when the vessels were laid up, and the others were considered as liable to be withdrawn without consultation with the Treasury Department. To so great an extent was this rotation carried, that more than half the officers composing the parties were changed in one year. The important work on the Nantucket Shoals was resumed in the summer of 1850 with a party, with the exception of a few officers, quite new to the work. The vessels of the survey were directed by the Navy Department, without consultation with that Department, to be turned over to the collectors of the customs at the close of the surveying season. The men usually allowed to take care of them were discharged; the officers in whose custody they must properly be, were, by orders from that Department, detached from the vessels and deprived of their commands, though necessarily retaining direction of the hydrographic parties to which they had previously been ordered, and which were engaged in office work, just as important and as proper a part of the hydrography as sounding. The passed midshipmen doing the duty of masters on board of our vessels were refused acting appointments as such. The lieutenants commanding were refused the clerks to which they were entitled by naval usage. The junior officers of the parties were detailed without regard to their fitness or disposition for this kind of work.

The whole of the hydrography on the Gulf of Mexico (viz: in Florida, Alabama, Mississippi, and Texas) was suspended for an average period of nearly six weeks, in the best working season of the year, by the delay in furnishing crews for the coast survey vessels. One of these vessels was taken by the chief of the navy yard at Pensacola, where she had been laid up for safe-keeping during the summer, and despatched, without authority of this Department, to Vera Cruz, thereby causing a further delay in the hydrography of the eighth section of more than two months.

So far has the disposition to administer details without reference to the wants of the coast survey been carried, that one of the chiefs of parties is now actually without a single naval officer attached to his immediate command, and the organization of the other parties now in the office, would be, with one exception, ineffective from the want of officers, but for the employment of clerks or draughtsmen for them by the coast survey.

The party for Texas still remains without its officers, while the civil parties have been at their posts since early in December. The steamer Jefferson is still without her complement of officers to go to California.

If this results from a deficient supply of officers, it is not seen how the efficiency of the survey would be increased by still further burthening the Navy Department. The remedy for this would seem to be to make the requisitions of this Department mandatory on the Navy Department, or else to authorize the dispensing with the employment of officers of the navy in the hydrography, whenever the detail cannot be made by the Navy Department.

The object of Congress to have as many officers of the navy employed as practicable, is not carried out, but from no fault on the part of this Department or of the administration of the coast survey.

If the public service really requires the use of these officers, it is certainly no justification for their being withheld that they are to serve under another department. The revenue officers were placed under naval control during the war with Mexico. Numbers of army officers serve entirely detached from the War Department, under the Department of the Interior, and that in cases where there is no call by law for combined service, as in this case. The chief of the corps of Topographical Engineers, while urging that the officers engaged in the boundary survey should serve under his control, and not under that of the Department of the Interior, admits as a special and necessary exception to this mode of service, the duty on the coast survey.

Whatever objection exists for the service of navy officers under the Treasury Department, applies with the same force to the service of army officers, which has never been deemed improper; and service of army officers under the Navy Department, and *vice versa*, is generally admitted to be impracticable. The law so provides, and, until it is altered, I submit that the execution of it should not be made such as to defeat its essential objects.

An intimation from the Navy Department, that it was desired to withdraw from participation in the coast survey, would seem to be preferable to embarassing the survey in its execution under the law. If does not, then the requisitions of this Department ould be complied with, as if mandatory.

3. In my report at the commencement of the session sketched the progress of the coast survey as follows:

"The trigonometrical portion of this survey now extends unbroken from Portland, in Maine, to within fifty miles of the Capes of the Chesapeake, and, with an interval of about one hundred miles, which is rapidly filling up, to a point beyond Cape Hatteras.

"It has been commenced in South Carolina, Georgia, and Florida; is complete in Alabama, and nearly so in Mississippi; and has been commenced in Louisiana and Texas. The other operations follow closely in their order, and the publication of the maps and charts keeps pace with the field-work. Nearly one-half of the coast of the Atlantic and of the Gulf of Mexico has been surveyed. Since our recent acquisitions of territory on the Pacific, parties attached to the survey have been actively employed on the coast, and have contributed important information to this Department in regard to the proper sites for light-houses and other aids to navigation."

Since that time, the detailed report of the Superintendent has been submitted to Congress, and has been ordered to be printed.

Nearly one-half of the coast on the Atlantic and Gulf of Mexico has now been surveyed, in a time which, if comparedwith foreign surveys, will show favorably in regard to rapidity of execution. The ordnance survey of Great Britain was commenced in the last century, (1791.) and it is not yet completed. The detached nautical surveys of its coast are also unfinished. In the hydrographic publications of Great Britain for 1849, numbering sixty-three, there were but eleven of its own coast. Great Britain has made an admirable contribution to the civilization of the world in her foreign hydrography, but one which has not yet been imitated by us even on a small scale. One year's cost of her hydrography (1845–'46) was $893,910; in 1845–'46 and '46–'47, it was equal to the whole coast survey appropriation to 1849; and in ten years amounted to five millions of dollars. This comparison might, if necessary, be greatly extended, and with the same results.

The practice of foreign countries is decidedly adverse to the employment of a permanent corps receiving regular pay and emoluments, independent of the appropriation for a work, for the execution of a temporary work. And the reason for this must be obvious on the least reflection.

That a corps having other and permanent duties will complete such a work rapidly or efficiently, is contrary to all experience.

4. When, in 1848–'49, a bill was offered in the Senate providing for the transfer of the coast survey to the Navy Department, the chief commercial and scientific bodies throughout the country presented remonstrances against the transfer. The American Academy of Arts and Sciences, the American Philosophical Society, and the Franklin Institute of Pennsylvania, made elaborate reports highly approving of the methods and progress of the survey; the Insurance Companies of Boston, the Marine Society of Boston, the Chamber of Commerce of the city of New York, the Board of Trade of Philadelphia, the Insurance Companies of Baltimore, the Faculty of St. John's College of Maryland, the Professors of the University of Virginia, the Chamber of Commerce of Charleston, and the citizens of Mobile, united in addressing Congress in favor of the work as organized.

The American Academy of Arts and Sciences says:

"In conclusion, it is the deliberate opinion of the committee that the present Superintendent of the United States Coast Survey has, by his able and judicious, his energetic and economical administration of this great national work, raised it to the highest state of successful activity and deserved popularity, and that he has thereby fulfilled the high expectations which were raised at his appointment."

The American Philosophical Society states—

"That the survey of the coast is a work which, from its importance to our citizens, recommends itself in the strongest manner to the protection of the Government. That the benefits of a scientific and practical character which have already been derived and are constantly resulting from it, are such as to repay abundantly the labor and expense which has been and may be hereafter devoted to it. That it has heretofore been conducted accurately, efficiently, and economically, and that there is every reason to believe that it will best thrive by being left with its present organization. And that, as well from the magnitude of the undertaking as from the skill and energy with which it has been conducted, it will prove honorable to those who first conceived it, and to those who have been engaged in its prosecution."

This Society also recommends the publication of the observations upon which the maps and charts resulting from the survey are founded, as well as the formulas for the computation and discussion of the observations, a subject which has been brought to the attention of this Department in several reports by the present Superintendent, and for which a special appropriation was asked by my immediate predecessor, but not granted.

The Franklin Institute conclude their report with the following:

"First. That the work is national in its character, and ought to be continued by the Federal Government upon a scale commensurate with its practical importance, and with the extent and variety of the objects which are benefited by its results.

"Second. That the manner in which it is at present organized is economical, efficient, and scientific—giving its results with sufficient rapidity, at moderate cost, and upon correct scientific and practical principles.

"Third. That its labors ought to be (as they now are) divided among the civil, military, and naval talent of the country, in order to secure to each of these departments that knowledge of its processes and determinations which are equally required by them all.

"Fourth. That the benefits which the nation has already obtained from it have fully justified its cost, and that those benefits ought now to be continued to the whole of the States of the Union, upon as broad and liberal a scale as the Government has hitherto applied."

The American Association for the advancement of Science, at their meeting, held in Cambridge in 1849, appointed a committee to consider the subject of the coast survey, whose report, entirely favorable to the administration of the work, was unanimously adopted by the scientific men then and there present from the different parts of the United States. Their opinions are expressed in the following resolution:

"*Resolved*, As the sense of the American Association for the advancement of Science, that the manner in which the coast survey of the United States has been conducted by Professor A. D. Bache, and those associated with him, is highly creditable to American science, that it promises great benefit to the commerce and navigation of the country, and it is eminently entitled to the continued favor of Congress."

This Association have since testified their undiminished confidence in the Superintendent of this work by electing him their President, the highest position which can be occupied by a scientific man in our country.

When the rumor reached Europe that the present organization of the coast survey was assailed, the venerable Humboldt and his compeer of the French Academy of Sciences, Arago, wrote to their friend and correspondent, Professor Schumacher, of Altona, expressing their decided opinions of the manner in which the survey was conducted, of the attainments of the Superintendent, and of the honor which our country obtained abroad from the successful prosecution of this great work.

No name stands before that of Arago in the science of the world, and he speaks of the possible loss of Professor Bache's services as a "misfortune which he desires to unite with all that Europe has most distinguished in science, to prevent."

"The officers of the American navy are (he says) proverbial for their gallantry; they know perfectly well every part of the nautical art; still I shall not do them wrong by stating that Professor Bache stands higher than they by a hundred cubits in matters of geodesy and physics of the globe. I will prove by various examples how very useful it is even for the faithfulness of results, that a man should be superior to the task entrusted to him."

Baron Humboldt addressing Professor Schumacher, says:

"You know, better than I do, in how high an estimation the director of the work for the survey of the coast stands, not only among us, but among all the most illustrious men who in France and England are interested in the study of geography and nautical astronomy. To the most solid knowledge of astronomy and mathematics, Mr. Bache unites in a very eminent degree that activity of mind and extent of views which render a work of practical utility profitable to the science of the physics of the globe. In a region of the globe where the direction of oceanic currents, the differences of temperature produced by these currents and by the upheaval of the bottom and the direction of the magnetic curves, offer so important phenomena to the navigators, such a great work could not be placed in better hands than those of Dr. Bache. The Government of the United States has acquired a new right to our gratitude by protecting nobly that which has arrested the attention of the hydrographers and astronomers of Europe. I should be glad to think that in a country where I am honored with so much good feeling, my feeble testimony might contribute to enliven the interest which is due to the excellent labors of Mr. Bache."

Professor Schumacher, the learned astronomer of Altona, transmitting these letters, says:

"You will see, by the enclosed letters of our common friends, M. Arago and the Baron de Humboldt, how anxious they are to know if the great work you have undertaken will remain in the hands to which the whole scientific world would have entrusted it. Let me hope that the fears they entertain are only founded upon vague rumors. Your country must be proud to call you its own, and will repay you in gratitude what you do for her scientific glory."

Was any testimony like this borne at home and abroad to the results produced between 1819 and 1832, when the survey was under the control of the Navy Department? Should not a work which has won such approval be not only free from attack, but be fostered by all the means at our disposal?

What is it likely that we shall gain by changing an organization which has produced such results?

5. It is now generally understood that detached nautical surveys cannot, as such, be joined together so as to form a continuous chart. Each one supposes the earth to be a plane, and though, for short distances, the errors do not become apparent, when a grouping of the results is attempted, the spheroidal form of the earth interposes an insurmountable obstacle to all accurate joining. Hence a continuous survey can only be made by geodetic methods. The most accurate mode of ascertaining distances between objects, not in the same plane, is by the measurement of a base line on a level piece of ground, and triangulating from it, connecting points which, although

ntervisible, are separated by rough ground or by water. The best mode of representing the features of a country is by a topographical survey, based upon a triangulation connecting remarkable points. The only mode of obtaining accurate results in hydrography is to connect the position on the water with ixed points, accurately determined on the land. These methods are the only ones admissible in the present state of science, and these are practised in our coast survey. Any other mode of surveying, on land or water, than these, would be time and money wasted. If we cannot execute the survey of our coast in the best manner, we should postpone it until means or science can be found adequate to the execution.

The great survey of France, by Delambre, Mechain, Biot, Arago, and their illustrious associates, is universally known as offering not only the ground-work of one of the most accurate maps which has ever been produced, but as connected with the admirable system of measures and weights adopted by the Republic, (1791.) The topographical details of that work yet remain to be finally completed. The hydrography employs a special corps of "hydrographic engineers," under the direction of the Nestor of hydrographers, Beautemps Beaufré, whose career as a hydrographer, commenced in the last century, has never been interrupted by the calls of other service. Neither he nor the members of his corps are naval officers, properly so called.

The survey of Prussia owes its fame to the illustrious astronomer, Bessel; that of Russia, to Struve; that of Hanover, to Gauss; that of Denmark, to Schumacher; of Upper Italy, to Carlini; all civilians. In the topographical details, corps organized for the purpose, or military corps of cognate duty, have been employed.

In Great Britain, the land survey of the empire, commenced in 1791, by the ordnance corps, is not now completed. The hydrography of her coast still lingers. The want of connexion between the two works produces delay, a repetition of work, want of system, and of minute accuracy.

Science is progressive, and the tendency of works executed by permanent corps, not partaking of the general movement of the day, is to become stationary. To confine a work to a particular class of men—to a caste, instead of looking for the best ability for its execution—is to insure that it shall be behind the times. We want no stronger proof of this than is presented by recent charts of the coast of Great Britain. The absence of the latitude and longitude of the leading points, of the corrected establishment of the port, are scientific defects; while the absence on most of them of sailing lines and ranges, and of indications of currents, and, on all, of sailing directions, show, as contrasted with our own charts, glaring practical [illegible]ciencies. The arrangement of the soundings at [illegible]les of squares, adopted on those charts, is a [illegible]d of natural methods of determining and re[illegible]ng the figure of the bottom of the sea, which [illegible]y the least, not worthy of imitation. It has been said, with truth, by an eminent philosopher, in speaking of the survey of the coast of the United States, that even for the faithfulness of results it is well that the conductor of such a survey should be uperior to his position.

Few nations have been satisfied with a mere nautical survey of its coast. The most elaborate and extensive arrangements in many of them have been made to supply complete surveys. Besides, nautical surveys of the chief parts of our coast exist, and it is useless to repeat them. Indeed, those made by Des Barres, under the authority of the British Government, before the Revolution, are of the same quality as such repetitions would now be. A geodetic survey, such as is in progress, is absolutely necessary. No country in the world has made such a survey of its coast by the employment of its navy.

6. When in 1834 the coast survey was transferred to the Navy Department by the President, who had by law at that time the regulation of the work, it was argued that, as the hydrography was about to be commenced, great facilities could be furnished for it by the Navy Department, and that these would be more willingly provided, if the work were entirely placed in the control of that department. The transfer was hardly made before all the objections stated by Mr. Hassler against it were verified. The regulations of the Navy Department were inapplicable to such a work—its system of accounts equally so; and so far from harmonious action, there was a constant jarring of all the elements, until the retransfer to the Treasury Department, at the end of two years, by President Jackson. That this arose from the organization of the Navy Department, and not from personal influences, is evident from the facts that Mr. Woodbury was Secretary of the Navy when the transfer was made, and Secretary of the Treasury when the retransfer took place, and that the same Superintendent was sustained under both organizations. The serving of officers of the army under the Navy Department is an anomaly, and the usages and rules of a military department are not understood by civilians, and impose restraints often found irksome and not advantageous to a civil work. The expected facilities were so far from being obtained that the first vessel required for hydrography was purchased, notwithstanding Mr. Hassler's remonstrances, from the funds of the coast survey; his earnest appeal to have the repairs necessary furnished by the Navy Department was denied, and the Attorney General, on being consulted, pronounced the same to be contrary to law. Nor does it appear, from the correspondence between the superintendent and the Navy Department, that the details of naval officers were readily procured, while the only officer of the line of the army upon the work was withdrawn by the War Department.

The experience, then, of the transfer of the coast survey, as organized in 1834—the employés composed, as now, of civilians, officers of the army and of the navy—does not tell in favor of such a transfer.

From 1819 to 1832, the responsibility of continuing the survey was, by the repeal of the law authorizing the employment of others than army and navy officers, thrown upon these two departments. Detached surveys of rivers and harbors were made from time to time, and hydrographic reconnoissances (termed surveys) of the coast of some of the States; but no general or connected survey of the coast was attempted, nor did the detached surveys yield fruit which, taken as a whole, was creditable to the Navy Department or the country. An inspection of the charts of the entrance of Chesapeake bay, of York river, of the coast of South Carolina, and others, will satisfy any one on this point. The inefficiency of such a desultory plan of operations was just what might have been expected from it.

What the character of the results was, is stated by the Hon. Samuel L. Southard, Secretary of the Navy in 1828, in reply to the Committee on Naval Affairs of the House of Representatives. Of the maps an charts obtained under the act of 1818, Mr. South says:

"They do not furnish a satisfactory survey of the coast for the following reasons:

"1. They exhibit detached parts, unconnected with each other;

"2. Are generally confined to the shores, and do not extend sufficiently far into the ocean;

"3. Were, many of them, made by incompetent men, with incompetent means;

"4. They were governed by no fixed and certain principles, or guides, in ascertaining the latitude and longitude of the principal points and positions;

"5. They do not embrace the whole coast.

"For these and other reasons they are unsafe; and, in many instances, useless and pernicious."

Mr. Southard was of opinion that no further powers than those given by the law of 1807, with an appropriation adequate to the object, were necessary to obtain a satisfactory survey of the coast.

In his report for 1828, Mr. Southard further remarks:

"Several resolutions have at various times been passed, directing the Department to cause surveys to be made * * * They have been made during the three last years, and the results communicated to Congress as they were received. * * * * These surveys, although executed as well as the circumstances in which the officers were placed would allow, and have probably been sufficient to answer the object of the resolutions, yet they do not afford materials for an accurate chart of the harbors, and the approaches to them, and assist but little towards a perfect knowledge of our coast, which can only be acquired by that scientific survey of the whole, the importance of which I have ventured to urge, and would again respectfully suggest."

Mr. Southard was a firm, true, and decided friend of the navy, and yet his convictions are expressed in language too plain to be misunderstood. Nothing has transpired since to warrant the assumption that the scientific organization then demanded, and now in successful operation, is not necessary to fulfil the requirements of science, and the wants of the country, commercial, naval, and military.

The fact that these charts, as published, are not in general use on board of naval vessels, carries with it the opinions of the navy as to their inadequacy, and the superiority of those charts which private enterprise has supplied over them. Made from the results obtained by navy officers, it might be expected that they would be kept in use by the Navy Department, and by the officers employed to distribute charts to the national vessels.

In regard to the economy of these detached surveys, Secretary Southard says:

"These surveys, with others, which, from time to time, have been made under the direction of the department, have, to a certain extent, been useful, but they have also been very expensive in proportion to their usefulness. Made under special appropriations and special acts of Congress, the officers and other means have to be collected at the time, and all the expense of organizing these means to be encountered at the commencement of every survey, and to be disposed of at their termination."

The entrance to New York bay and harbor was left without any general survey, except such positions as private enterprise effected until 1834, when the work of the coast survey was commenced, and the first map published by authority of the Government, of the port where nine-tenths of the duties of the country are collected, and published at the Office of the Coast Survey, in 1844. Gedney's channel remained to be discovered in 1835; Davis's South shoal in 1846.

On repeated representations of Mr. Southard and others, and a full consideration of the experience which had been acquired, Congress revived the law of 1807, extending its powers so as to give the President authority to employ army and navy officers as well as civilians. The work was again placed under the Treasury Department, and Mr. Hassler appointed Superintendent.

If it were desired to convert the navy into astronomers, surveyors, and topographers, or philosophers, this, no doubt, could be done by preparing them suitably in the Naval Academy, and giving them full opportunities for study and practice afterwards; but just in proportion as they become expert in these branches, would they cease to be naval officers, and if another war should come, we should be found to have exchanged the hardy character of the navy of 1812 for something less able to cope with the "Mistress of the Seas." As far as the coast survey might be used for such a purpose, it would prove an injury to both the navy and the country. The concentration of civil works in the hands of the navy, is calculated entirely to disorganize that service.

It may be said that the navy has now acquired experience in this work itself, by which they are competent now to conduct it. This is not the case, for the navy has not learned the land-work which constitutes four-fifths of the whole. This argument also supposes the coast survey to be stationary, whereas every year, as science advances, the work advances with it. Witness all the improvements in astronomical and magnetic instruments, and methods in geodetic instruments, and processes in telegraph operations, applied to geodesy, in topography, and even in hydrography, within the past ten years.

7. The organization of this work, and the arrangement of all the details of expenditure, are such as to insure the most rigid economy.

Any array of figures which separates the cost of a work from its results, can give no valid information as to its economy. The amounts expended in different periods of the survey as derived from direct appropriation, and from the supply of officers and men from the Navy Department, have been stated by this Department, in an official report, as late as the year 1849, and to this report I refer as containing the minute details of the subject. (Exec. Doc., No. 16, Senate 30th Congress, 2d session.)

If we compare it with foreign surveys, we find that our land-work cost per acre not one-half or one-third the cost of foreign surveys. Thus my predecessor states: (Senate Doc., No. 26, 30th Congress, 2d session.)

"I have taken some pains to inform myself in regard to the relative cost of this and foreign works of a similar kind. Of these, two of the most important works are those of France and Great Britain.

"The tertiary triangulation and topography of Fr[illegible] an cost, on an average, one hundred dollars per squa[illegible] or fifteen cents and six mills per acre. This is ex[illegible]etached the cost of the great geodetic work by Delambre [illegible]ogether Biot, Arago, and others. [illegible]pposed

"The estimates in 1847 for the secondary triangulation and topography of the trigonometrical survey of Great Britain, commenced in 1791, by the ordnance corps, are at the rate of $103 81 per square mile, or sixteen cents and two mills per acre. This is exclusive of the army-pay of the ordnance officers, but inclusive of the pay of three companies of sappers, numbering 315, employed upon the work.

"The near approximation of these sums to each other, indicate that they are standards of comparison; they average fifteen cents and nine mills per acre, which is between twice and three times the cost of an acre of secondary triangulation and of topography taken together, in the coast survey, as shown by the expenditures of 1847 and 1848.

"The surveys of Wurtemburg and Hesse Darmstadt cost, respectively, 25 and 20 cents per acre.

"Similar data for the cost of the hydrography in foreign countries, are not before me; but I may mention that the appropriations for hydrography alone, made annually by Great Britain as a contribution to the navigation and commerce of the world, have amounted in ten years—from 1837 to 1847—to more than four times the appropriation for the survey of the coast of the United States, land-work and hydrography both inclusive; and this is besides the appropriation for the trigonometrical survey."

The comparison of the land-work with that of our own land surveys, shows, that with all the topographical detail which is introduced on the coast survey maps, the cost of the work, exclusive of reduced drawings, was less than the average cost of the land surveys of the United States; (Reports of Superintendent Coast Survey, 1848 and 1851,) also without drawings. Including the astronomical and geodetic work, the measurement of bases, and the triangulations, the cost of the land-work does not reach the maximum paid for surveys of the public lands. When the value of the complete work is thus compared with that in which the geographical positions of points are entirely undetermined, it shows the economy of the coast survey in a strong light. These comparisons were made in years when the number of officers of the army on the work being small, the result was not sensibly effected by their employment.

The cost of the hydrography is less under the control of this Department than other parts of the work, since the requisitions made by the officers in charge of the hydrographic parties depend upon views acquired in the naval service, and can only be controlled by naval allowances and usages. It is believed that all the economy which can be practised within the limits of the organization is effected, and that all the expenditures are closely supervised. There is nothing, however, in the comparison between this part of the survey and others, to show that this is the most economical part of the work, or to lead to the inference, that, if by an increase of the navy, the whole survey were placed in the hands of naval officers, its economy would be greater than at present. Upon this subject, it is not necessary to go further into particulars, though it can be done if desired.

8. It is very difficult to ascertain the cost of the surveys heretofore made under the Navy Department, for the appropriations give no idea of the money spent upon them, having been applied merely to cover the extra pay of the officers employed, while vessels were built, or purchased, or hired, repaired, supplied, their crews paid, and numerous officers furnished, and their transportation paid, without the expense being charged [illegible] these surveys. If it be contended that the officers de[illegible] have been paid if not so employed, it may be the an[illegible] at they would have received shore and not disregar[illegible] much less extra pay, and that vessels, sup- presenti[illegible] ien, constituting the larger part of the ex- is, to s[illegible] re, would not have been paid for at all, unless so employed. The practice of thus covering up expenditures is erroneous. The principle that officers not wanted are to be retained in service and occupation found for them—it may be, the most uncongenial to their professional pursuits—is one that requires only to be broadly stated to command universal dissent.

Under the control of the Navy Department the survey of four harbors (including a river of inconsiderable length in connexion with one of them) cost the large sum of $63,023. A complete survey of the same in connexion with the coast survey would not cost *one-fourth of this sum*. But this sum of $63,000 does not cover all the expenses, since it excludes the cost of vessels, outfits, supplies, and transportation. It includes, however, the leave-of-absence pay of the officers, which strictly should not be charged to the work. The amount of this would have been about $12,204; say $51,000 and upwards for the cost of this limited work.

Again, the cost of the survey, under the direction of the Navy Department, of three harbors on the Gulf of Mexico was, exclusive of vessels, outfits, &c., eighty-three thousand two hundred and thirty-three dollars ($83,233.) The complete survey of one of these harbors, by the coast survey, under this Department, including the land and water, and the pay and rations of the officers and men from the navy, would cost four thousand one hundred dollars ($4,100;) and it is estimated that the whole three could have been surveyed under the same direction for less than fifteen thousand dollars, which is between one-fifth and one-sixth of the actual cost under the Navy Department. If the difference between the leave-of-absence and actual pay of the officers of the navy, employed in these surveys, is deducted from their cost, it leaves $57,000, or nearly four times the cost which would be incurred under this Department.

These two surveys, together, give an expenditure of $140,000, which is greater than the whole cost, including every expense of pay and all other items, of the whole hydrography of the coast survey, from Maine to Texas, for a year and a half.

I do not give the names of the localities surveyed, because not intending to cast censure on the officers who executed this work, but merely to show the very great expenditure under the usual allowances for the execution of surveys under the Navy Department.

I have selected these cases because, being of comparatively recent date, it has been found practicable to obtain the items of expenditure from the pay rolls and accounts in the Auditor's office without too great loss of time.

The question is not of a small difference depending upon nice calculation, but of four and sixfold economy in favor of execution of the work by this department. No question is made either of the relative value of the results of a mere nautical survey, and of a geodetic work with all its accuracy and refinements.

To secure the control of expenditures by the legislative, appropriations should as far as practicable be direct.

The covering up of expenditures by making large appropriations nominally for a particular object, and their use in some other, cannot fail to give rise to abuses. A survey of the coast having been determined upon, it is better that the full amount of all its expenditures should be known, than that by drawing its materials, supplies, or personnel from large contingent or pay funds, the actual expenses should not appear.

The execution of the hydrography of the coast survey by officers of the navy has led twice to inquiries as to the amoun of expenditure thus indirectly made. The whole amoun thus derived, from 1832 to 1849, (seventeen years,) wa stated by my predecessor at $252,000; being the whole dif ference of pay and emoluments of officers on leave of absence and at sea, and the pay and rations of the men employed in the coast survey vessels.

The average salary of the superintendent, assistants and sub-assistants of the coast survey in 1843 was about tw thousand dollars per annum; at present the average is about fourteen hundred dollars. The average of the salaries of the superintendent and assistants at the National Observatory, under the charge of the Navy Department, is estimated for 1851 at thirteen hundred and sixty dollars. The whole number of assistants and sub-assistants attached to the field-parties in the coast survey, including those on the western coast, n January 1851, was twenty-seven; and the number of assistants and sub-assistants estimated by the Navy Department as necessary in the Observatory, a single establishment, was twenty-five. As the civilians thus employed on the coast survey are greatly exposed in the execution of their duty, it will be more fair to make a comparison with the assistants engaged in the office of the coast survey: those, including the computers, draughtsmen, and recorders, are twenty-five in number, receiving an average salary of six hundred and eighty-three dollars, or less by six hundred and seventy-seven dollars than in the Observatory. It appears from this that the administration under the Treasury Department may in reality be more economical than under the Navy Department.

It will be observed that in no case where the direction of scientific works has been undertaken by officers of the navy has the service been permanently rendered with the emolument of the grade to which the officer belongs, and that in all the surveys undertaken by the Navy Department between 1819 and 1832 extra pay was allowed to the officers, and that up to last year the appropriation bill contained items for extra pay for surveys made ten years ago.

It will further appear that in scientific works, nominally undertaken by the navy, or under the control of the Navy Department, it is necessary to employ large numbers of civilians, under some name other.

If civilians are to be employed, the advantage of placing the work under a military department does not appear.

To cite another case of comparison of works directed by the Navy and Treasury Departments, the cost of the exploring expedition fitted out under the Navy Department in 1838 was, for four years, nearly $972,721.81, or $243,180 per year, exclusive of the cost of the vessels employed and outfits, which would greatly increase this sum, and exclusive of the expenses since incurred in reducing and publishing the results, for which $94,400 was appropriated between 1842 and 1846. (Senate Doc. 27th Cong. 1st ses.) It is not intended to deny the advantages of the expedition, nor to cast any censure upon its expenditures, but simply to defend the economy of the survey of the coast under the administration of this department. The largest appropriation asked for the coast of the Atlantic and Gulf of Mexico in one year has been $216,000; that to meet the unusual condition of things on the Western coast and the purchase of a steam vessel is $415,000, and the average appropriation but $90,000.

9. The number of officers of the navy on coast survy service in June, 1850, was 14 lieutenants and 17 passed midshipmen, &c.—total 31. In December, 1850, the number was 16 lieutenants and 17 passed midshipmen—total 33. These were distributed in ten hydrographical parties, each one under the direction of a naval officer. Each single hydrographic party then numbers in the average from three to four officers, and when in commission, surveying, four to six officers. During the surveying season these parties have been distributed along the coast, as shown in the table accompanying the report of the superintendent of the coast survey. They have executed hydrographic work in Maine, Massachusetts, New York, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Texas, California, and Oregon.

In 1839, under the Navy Department, fourteen officers were employed in surveying one river and three harbors in three adjacent States on the Atlantic; in 1840–'41 twenty-four in surveying three harbors in three adjacent States on the Gulf of Mexico. The advantage in the present organization of work will appear by contrasting these numbers with those [illegible]xion with this it should be recollected that demands were made for additional officers for coast survey service, which have only been complied with by ordering officers already on duty and usefully employed from the parties in which they are serving in the office to others which are in commission, taking thus from the efficiency of one part of the work to make up details for another.

Thus in two surveying parties, on a very limited portion of the coast, and engaged in surveying harbors, more officers were employed than on [illegible] represent the whole hydrography of the coast survey. I have before shown the large expense of these surveys compared with surveys of the same localities under this department.

10. A comparison between the cost of repairs to vessels employed in the coast survey and those in the naval service will not, it is believed, be found to the disadvantage of this department; it is very certain that the officers in command of the coast survey vessels, who have tried the experiment of having repairs made in the navy yards to be paid for by the coast survey, have not repeated the experiment. When the brig Washington was injured in the hurricane of October, 1846, the Navy Department liberally agreed to receive her for use as a cruiser in the Gulf of Mexico for a certain time to pay for her repairs. She was transferred to the Navy Department, and fitted entirely under their control, and when the question of payment was raised the expenditure had exceeded the original cost of the vessel. So also in the repairs made to the schooner Nympth, (twenty tons,) which had been loaned to the officer in command of the expedition to Round Island, the bill for repairs made at a navy yard was so large that it was determined to give up the vessel to the Navy Department rather than meet it. The cost of these repairs was within about $400 of the cost of the vessel itself.

Whatever advantage there may be in doing such work upon large vessels which are beyond the means and appliances of ordinary shipwrights, it is bad economy to have small vessels repaired except at places where private competition makes prices reasonable. This department has acted upon this known fact in repairing its revenue vessels. The use of a dry-dock at a particular point may occasionally save expense, and since this use is freely afforded as a matter of comity to foreign national vessels needing repairs, there should be no difficulty in obtaining it for our uses when needed. The coast survey vessels are scattered along the coast at points where there are no special naval facilities, and the greater number of them are of such small size that their passages from point to point by sea are attended with great risk; it is better and much more economical to lay them up where they are used during the season or near it, than to collect them at a central depot or station. The care of the vessel by a respectable and responsible citizen living near the point where she is to be laid up is easily secured.

There would be no economy in substituting repairs at navy yards for repairs by private competition.

It is sometimes represented that there are articles belonging to navy yards unfit for use by the vessels of the class belonging to the navy, but which might be serviceable to our small vessels, and yet which if sold would bring but a low price. If this be so, it is conceived that they should be furnished on the requisition of the officers of the coast survey, or at least that their purchase from the funds of the work should be permitted on as favorable terms as those upon which they are disposed of to others. In most cases the cost of taking a coast-survey vessel to the navy yard would be greater than the benefit to be derived from such facilities.

The cost of repairs to the ten vessels used in the hydrography, including those to the boilers and engines of the five steam vessels, borne by the coast survey appropriations without aid from any extraneous source whatever, was in 1829 $16,604.37. This is not half the cost of wear and tear of part of these steam vessels when used in the revenue.

The cost of repairs to the ten small vessels used as means of transportation by the land parties was $3,000; averaging but $300 per vessel. The cost of repairs up to 1849 is stated in detail in Senate Executive Document No 29, 30th Congress 2d session, page 6.

In passing, I may remark that this department is not officially informed in regard to, and is in nowise responsible for, the cost of repairs made at navy yards by consent of the Navy Department on the application of officers of the navy connected with the survey. My predecessor applied (Ex. Doc. No. 29, Senate, 30th Cong. 2d sess., p. 2) to the Navy Department to ascertain this amount, but no communication was received in reply. The steamer Walker, belonging to this Department, it is known has, while placed for safekeeping at navy yard, been twice prepared for putting in commission without consultation with or authority of this department, and or purposes entirely unconnected with the coast survey, in ne instance to the great hindrance of the work.

11. From 1844 to 1848, while the appropriations asked for he coast survey were increased twofold, the amount of work executed was more than threefold. This economy resulted rom the division of labor which an increased scale permits, and from the vigorous pushing of the work at the South as well as at the North, by which the best season for surveying s used by the same persons in each region.

It is not a little remarkable that the increase in the appropriations for this work beyond those just referred to have come rom the legislative branch of the Government, showing at once the realizing sense of the importance of an extension of he survey and the confidence in the mode of administering it. Thus, in 1849, a call was made in the Senate upon the Secretary of the Treasury for information as to a survey of he Florida reefs and keys, and a special appropriation of $30,000 was introduced in that body for commencing the work. This appropriation has since been asked without increase by the department. So also an item for the western coast of $150,000 was introduced by legislative motion.

The fact is, that the coast has extended, first by the annexation of Texas, and then by the admission of California and erection of Oregon into a territory since 1843, not less than three thousand two hundred miles, and the rapid extension of the commerce on the western coast requires absolutely provision for its speedy survey, notwithstanding the expense arising from the high rate of wages there. The economy of the civilians there engaged may be set up, however, as a model when the conjoined salaries of the officers of four parties are but five thousand dollars. The efficiency of the organization is proved by the fact that in such a disturbed state of things a reconnoissance was made from Monterey to the Columbia river ; and the charts (three sheets) were engraved on copper, published, and sent to the western coast in twenty-two working days from the time of their reception at the office.

At the close of 1844 it became obvious to the Superintendent of the survey that thirty years of progress at the then rate of appropriation and plan of operating would not take the survey to the mouth of the Mississippi. He stated frankly in his report the necessity for greater expedition, and the plan by which it could be attained—the division of the coast into sections, and the commencement of the survey in as many as Congress would provide appropriations for. At this time Texas was not annexed, and the western coast was not in the possession of the United States.

This plan has received the sanction of Congress in sucessive years from 1844 up to the present, when every appropriation asked for, except that for the Florida reefs, which is the same as last year, is less than was appropriated about three months ago for the same service for the present fiscal year.

Nor is this increase like that of an appropriation for a branch of service which must always have an existence, since it decreases the time during which the survey will last.

The work is nearly half done now. The remainder will be accomplished on this side of the continent in from twelve to fifteen years with the present rate of appropriations. The gain of time being greater in proportion than the increase of expenditure, there is an economy in money in thus conducting the work, amounting to the proportion, as I have elsewhere stated, of one and three-fourths to one.

At the average rate of progress between 1832 and 1844 the survey would have required one hundred years for its completion ; at the present rate what remains of the coast of the Atlantic and Gulf of Mexico will be completed in from twelve to fifteen years.

If it is preferred to adopt a less rapid rate of progress, it can be done, but at a sacrifice of economy. It is submitted, however, that now, while the country is prosperous, is the time to press the work forward. It is also submitted that the spirit manifested by those engaged in the work of pressing it to completion is in the highest degree unselfish, and should be fostered, and that they should be cheered on, rather than discouraged in their efforts.

When the Mexican war broke out there were fourteen officers of the army upon the work, all but three of whom were withdrawn. Notice was given that the navy officers might necessarily be withdrawn Had there been no civil corps, in such an event the work would have been stopped just when a knowledge of our harbors was most wanted.

The present occasion of peace appears to be the one for pressing forward the survey.

A change in the present organization of the work would be productive of much loss of time and useless expenditure. If it were determined that the best organization for the survey of the coast would be an exclusively naval one—which reason and experience both contradict—still, in a work which is nearly done, the change would be inexpedient, involving a severe loss of efficiency and a considerable postponement in its completion.

In the beginning of this work, neither the Executive nor Congress deemed it proper to commit it to the navy of the United States, so that the question does not now occur as to what would be the best organization of a new work, but of the interruption of a work nearly half finished in quantity and more than half finished in time.

The present Superintendent is versed not only in the general principles, but, in every detail of this work, has visited nearly every part of the coast, and is intimately acquainted with their necessities and the resources from which they are to be supplied. The assistants are all trained in their particular occupations, thoroughly trained and perfectly acquainted with the parts of the country in which they are called upon to work. The hydrography is in the hands of officers of the navy, who have had at least two years, and several of them more experience in the work. To lose all this experience by a change would, in my opinion, be the most injudicious course which could be taken.

12. It is not desired to disturb the present organization, because it combines efficiency and economy with the instruction of officers in two important branches of the public service; but if Congress should desire a plan for conducting the work, in which economy and efficiency would alone be consulted, I feel bound to say that I could present one which, retaining in employment on the land the civilians and officers of the army, and in the hydrography a certain number of officers of the navy to be permanently attached to the work, would combine greater efficiency and economy than the present system of rotation. The sailors employed in our naval service are not the materials suited to this work. They are, by the present arrangement, changed almost entirely every cruise, so that each new surveying season is to be begun with raw recruits, whose drilling must be paid for. Nor does the Government gain even the amount of their pay, for they are enlisted solely for this service, and would not be employed if not used by the survey.

13. A list of the observations of every kind, of the topographical maps and hydrographical charts, made in the progress of the coast survey, was given by this department up t January, 1849, (Senate executive document No. 26, thirtiet Congress, second session.) The following abstract will shov the increase up to the first of the present year, as far as the results have yet been reported to the office of the survey, viz :

Reconnaissance, area in square miles..........	55,51
Triangulation do do do............	39,51
Topography do do do............	9,76
Do shore line......................	12,08
Hydrography, area in square miles............	37,93
Do No. of soundings..............	2,263,70
Gulf stream, No. of soundings for temperature....	1,41
Do do fathoms of line used........	140,05
No. of manuscript maps......................	69
No. of sheets...............................	90
Contents of drawing paper in square feet........	11,446
No. of volumes of observations and computations of astronomical, geodetic, and hydrographic work..	2,496
No. of volumes tidal stations..................	66
Do do current stations..................	69

The following may be considered as among the most prominent developments made on our coast, most of them being real discoveries. They refer necessarily to the hydrograpby, since determinations made on land, though of previously unknown positions or distances, are not thus termed. Without the land work of the survey, these discoveries would either not have been made at all, or else have been very imperfectly developed.

1. Gedney's channel into New York bay, having two feet more water in it than the old channel.

Had the true depth of water in this channel been known in 1778, the Frencb fleet, under Count D'Estaing, would have passed into the bay and taken the assembled British vessels. It is probable, from comparing the old and new charts, that this channel then existed.

2. Blake's channel into the Delaware; open when the Eastern channel is filled with ice.

This discovery has already developed the resources of that part of the State of Delaware in a remarkable way.

3. Davis's New South Shoal, discovered in 1836, six miles north of the old Nantucket South Shoals.

This shoal lies in the track of all vessels between New York and Europe, and between New England and the Southern States, or New England and South America.

4. Two feet more water into Mobile bay than existed six years ago. Mobile entrance has now $20\frac{3}{4}$ feet at low water.

5. Horn Island channel, on the coast of the Mississippi.

5. Blunt's channel into Delaware bay.

7. Numerous rocks in Long Island Sound and Martba's Vineyard Sound, and the various bays and harbors connected with them.

8. Two shoals north and east of Nantucket discovered in 1847.

9. Six shoals near Nantucket, the outermost one fourteen and a half miles from land, and having but ten feet of water on it, not marked on any existing chart.

10. The remarkable increase of Sandy Hook, which has been traced from the surveys of the topographical engineers and of the coast surveys.

11. The changes in the Delaware neer the Peapatch.

12. McArthur's shoal at the mouth of tbe Great and Little Choptank, in the Chesapeake bay.

13. Four shoals in the main ship channel over the Nantucket shoals.

14. McBlair's shoals off Nantucket, in 1849.

15. Deeper water found on Diamond shoals than was supposed te exist, and a dangerous nine-feet shoal found off Cape Hatteras in 1850.

16. Hetzel shoal off Cape Canaveral, Florida, in 1850.

17. New channel into Key West.

18. New channel into Charleston, with the same depth of water as the ship channel.

19. South channel of Columbia river surveyed and rendered available to commerce.

The following is a list of the maps publisbed at the Coast Survey Office, and of those which are in progress:

Maps and Sketches published.—1, New York bay and har-or and approaches, one sheet; 2 to 7, the same in six sheets, rge scale; 8 to 11, Delaware bay and approacbes; 12, New edford harbor; 13, New London harbor; 14, Fisher's Island ound; 15, Holmes's Hole and Tarpaulin Cove harbors; 16, yster or Syosset bay 17, Little Egg harbor; 18, Harbor of nnapolis; 19, New Haven harbor; 20, harbor of Edgartown; 1, harbors of Black Rock and Bridgeport; 22, Huntington ay; 23, Nantucket harbor; 24, barbors of Sheffield and awkin's Islands; 25, moutb of Chester river; 26, harbors f Captain's Islands, east and west; 27, Long Island sound, heet No. 2; 28, Long Island sound, Sheet No. 3; 29, ketcb chart of Nantucket shoals; 30, sketch chart of Butermilk channel, New York harbor; 31, sketch chart of Cape Hatteras cove; 32, sketch chart of Cape Hatteras inlet; 33, sketch cbart of Bull's bay barbor; 34, re-engraving lower sheet of the Delaware; 35, Pasquotank river; 36, Cat and Ship Island harbors; 37, harbor of Hyannis; 38, sketch chart Beaufort harbor, North Carolina; 39, sketch chart St. Andrew's shoals, Georgia; 40, sketch chart Nantucket shoals; 31, Hatteras inlet, from re-survey; 42, Cape Canaveral shoals; 43, sea coast, Maryland and Delaware; 44 to 46, reconnaisance of western coast from Monterey to Columbia river, in three sheets.

The following named Maps are engraving.—1, general chart of the coast; 2, No. 1 Long Island sound; 3, No. 1 Chesapeake bay; 4, No. 1 south side Long Island; 5, No. 2 south side Long Island; 6, No. 1 eastern series; 7, Boston harbor; 8, Sachem's Head and city Island; 9, Muskeget channel; 10, Mobile entrance; 11, Hell Gate; 12 to 32, annual sketches for annual report of 1850; 33, preliminary survey of Columbia river.

The following Maps and Sketches have been drawn at the office within the year.—1 and 2, map of Boston harbor, Commissioner's copy; 3, Muskeget channel; 4, eastern series No. 1; 5, Long Island sound No. 1; 6, Long Island sound No. 2; 7, Hell Gate; 8, Mobile entrance; 9, mouth of the Connecticut river; 10, the typography of Charleston harbor; 11, sketch of Nantucket sboals; 12, sketch of Canaveral shoals; 13, sketch of St. Andrew's shoals; 14, sketch of Maryland and Delaware sea coast; 15, sketch of Beaufort harbor; 16, sketch of Sandy Hook changes; 17, sketch of Hatteras shoals.

The following are in the hands of the Draughtsmen.—1, Chesapeake bay, No. 1, nearly finished; 2, Chesapeake bay No. 2, just commenced; 3, the typograpby ot tbe Patapsco, so far as the field work admits; 4, the typography of Boston harbor, for engraving; 5, the typography of general coast chart; 6, Mobile bay No. 1; 7, Mobile bay No. 2; 8, Albemarle sound No. 1; 9, Well-fleet barbor, nearly completed; 10, Hart and City Island, nearly completed; 11, Key West harbor, just commenced.

The accumulation of useful results is very great, and the activity in their publication not less so. Within the past year tbe following hydrographic notices have been published by authority of this department, and distributed to those engaged in commerce: 1. Hatteras shoals, North Carolina; 2. Hatteras Inlet, North Carolina; 3. St. Helena Sound, South Carolina; 4. St. Andrew's sboals, Georgia; 5. Surveying marks on the Florida reef; 6. General description of tbe Florida keys; 7. Shoals off Cape Canaveral, Florida; 8. Sailing directions for the Western coast from Monterey to the Columbia river; 9. Hydrographic notices of the Western coast within the same limit; 10. Notes on the south channel of Columbia river.

These have been collected and printed for distribution, and every few weeks adds to the list some useful notice to navigators.

I risk nothing in affirming that, in no country either our own or foreign, has so great an amount of results been obtained at so small a cost as this. If these results be compared with tbose obtained by the Navy Department between 1819 and 1832, in quantity, even without regard to quality, (wbich must render the comparison too unfavorable to a kindred department,) and the cost of the two be compared, it will settle the question in favor of the relative economy of the present organization, without leaving a doubt.

The following is a brief view of the improvements introduced into the survey, as given in a report by the Superintendent:

New astronomical instruments and methods bave been introduced after subjecting the results obtained by former ones to discussion by the modern methods of analysis, and proving thus the necessity for the change. By the instruments now used the latitudes of places can be determined with greater precision than that to which the places of the small stars are given in the catalogues, and it is now necessary to resort to direct observations for their places. The methods of observations of azimuth and the computations have been greatly improved. Irregular attraction of the plumb line has been found in places where it has hitberto not been supposed to exist, and the remedy for the irregularities in local attractions, latitude and azimuth bas been applied.

Differences of longitude have been determined by the electro-magnetic telegraph between the stations at Cambridge, New York, Philadelphia, Washington, and Charleston; and also between Washington and Cincinnati, as a step in the chain between Washington and New Orleans. This is the first public work in which this method has been used, and the first of any kind in which it has been perfected.

Regular observations for the difference in longitude of a point in the survey with European observations have been made, first by the use of the chronometers of the Cunard steamers, and when the limit of accuracy thus attainable had been reached, by the transportation of chronometers, specially prepared for the purpose, between Cambridge and Liverpool. Astronomical observations have been collected from various sources for the same purpose, and have been discussed by the modern methods.

A new base apparatus has been devised by the Superintendent and constructed under his direction, by which the accuracy of such measurements is increased and the time required for them diminished. It is arranged so as to be of invariable length at all temperatures, and when the temperature is rising and falling.

The topographical system of Lehman has been introduced into the survey, and modified so as to adapt it to representing the slopes of our coast. Scales of shade depending upon it have been introduced into the field work, and the drawing reduced in the office.

Improvements have been introduced into the mode of observing currents and of reducing and representing the observations. The recent methods of tidal reductions have been introduced upon the work.

The Gulf stream has been explored from Hatteras northward to the parallel of Cape Cod, by instruments devised for ascertaining temperatures below the surface where the accidental effects of winds are not felt. The division of the Gulf stream into two branches has been discovered by the use of these instruments, and the "cold wall" limiting the stream inshore has been traced. The law of decrease of temperature below the surface has been developed by the same methods.

The geodetic formulæ and tables introduced have been founded on careful mathematical analysis and on the most recent determinations of the figure of the earth.

New plans for reducing drawings, for system in engraving, for copying engraved maps by the electrotype process for printing, have been introduced.

A classification of the specimens of the bottom of the sea sea has been made, with results interesting to navigation and to science.

Tidal observations have been collected at each of the principal ports that have been surveyed, and provision has been made for their continuance.

The remarkable phenomena of the single day tides in the Gulf of Mexico have been developed, so that practical tables may be given for the places at which the observations have been made.

The progressive character of the work will appear from the least consideration of this list, and the necessity of retaining its connexion with the science of the country, in order that this character may be preserved.

14. It is frequently urged that the changes on our coast will in time render the hydrography of the coast survey obsolete, and require new surveys. If so they can be made at comparatively small expense by the land determinations of the present survey. But the allegation is not true in a general sense, but, on the contrary, in the progress of the coast survey, the parts of the coasts which are changing, and those which are permanent, become distinguished from each other. Thus no change of any importance in the channels entering New York harbor or Delaware Bay has taken place since the surveys of 1836 and 1843, although such changes have been alleged, and re-examinations have been made to determine the facts. Davis's south shoal, south of Nantucket, has undergone no material change since its discovery in 1846, though the contrary of this fact has been stated; and we might suppose, *a priori*, that considerable changes at short intervals would occur in such a locality. It is, indeed, more than probable that Gedney's channel, discovered by the coast survey in 1835, was actually in existence when Des Barres' map was made in 1780, and the French fleet, under D'Estaing, anchored off the entrance in 1778. Had it then been known, New York city would have been rescued from the occupation of the enemy, and the occurrence of a long train of disasters in our revolutionary struggles would have been prevented.

15. The chief of the hydrographic party is responsible for the due execution of the scientific directions which he receives, and which can emanate from no one so well as the general superintendent of the work, who sees all the parts, arranges all the complex operations, so that they will fit together aptly, watches their progress by the monthly reports of the assistants, and is thus enabled to ensure the proportionate progress of every part of the survey. The tendency, in a work executed by many different individuals, is the want of connexion in methods and operations. Each one sees only his own part of the work, considers it essential, and those of others of less importance. The unity which is entirely and absolutely necessary to success in such operations is secured by superintendence, which, knowing the wants of each part of the work, causes it to advance as one operation. If the direction of the topography were disconnected from the triangulation, confusion would be produced, and the topographer would be obliged to determine over again the points executed by the triangulator. The difficulties which now and then occur, under even a well-regulated system, in finding the points and marks left by the preceding party, who, intent on their own work, sometimes think too little of those who are to follow them, would become the rule instead of the exception. The hydrogaphy would in like manner suffer, not as now by incidental carelessness or the wanton removal of a signal, but necessarily and generally; and it would be found at last, as in the British surveys, that they must determine a second time their shore line and points of reference on the land. The loss of time and additional expense thus involved can be hardly foreseen. The differences, too, would be charged by each on the other as errors, and there being no authority to appeal to for a verification, all confidence would soon be lost in the determinations. The work would inevitably require to be done a second time under a proper system.

It is very certain that if the work is done now by any but the most complete and perfect methods, it will hereafter be done over by such methods, and the expense now incurred and the time occupied will be thrown away.

It is not possible to separate the parts of the work without destroying it.

16. By dispensing with the land work we would fall back upon a nautical survey. We have had such, before the Revolution, of a considerable part of the coast. We have been furnished since with additions to this class of surveys. The whole forms no part of such a survey of our coast as commerce desires, as was intended in the beginning of the work, and as the science of the day demands. If we concede that the land work is essential, then the question comes: could it be better executed if the survey was under the direction of the Navy Department? If it is still to be made by the persons now employed, it is not perceived what special gain there would be by placing it under another department. The Treasury Department would seem to present all the facilities for administration which could be found elsewhere. The present organization admits of any number of the land parties being placed under the general direction of an experienced civilian, or of an officer of the army; it is not seen how this would be improved by substituting an officer of the navy for the former. If the work is actually to be performed ashore by the officers and men of the navy, then must the former leave their element and degenerate gradually into landsmen; and the latter, without being particularly good chainmen, signal-bearers, or assistants about an instrument, lose the nautical tact which it is so important they should preserve, replacing in their employment the citizens of the district where the survey is making, who are now employed, and exchanging, in many cases, their vessels and boats for tents and

wagons, and losing altogether their nautical habits and experience. They would be paid as sailors and employed as landsmen; the higher their nautical qualities the worse for the land, and the coast survey, instead of furnishing a school for coasting sailors, would convert every year a certain number of sailors into landsmen.

17. The idea that the coast survey should be transferred to the navy seems to involve the other, that there are more naval officers than can be appropriately employed. The uses of a navy even in time of peace might, if it were the province of this department to interfere in such a matter, be broadly stated. If the naval service is too numerous, upon which I do not venture to give an opinion, then should it be decreased, as was done by this department with the revenue service. To assume the necessity for increased duties in time of peace is to assume too large a personnel of the service for a peace establishment.

The importance of a navy to the protection of commerce will necessarily appear less forcibly as it may be efficient in preventing the occurrence of depredations upon it by lawless combinations.

18. It has been supposed that if the survey were entrusted entirely to the navy, outside work would be increased in proportion; but experience does not confirm this. Rivers, harbors, and bays formed the chief staple of the surveys from 1819 to 1832, and this Department knows that the exertions of the present Superintendent to obtain outside work have not always proved as successful as was desirable for the regular progress of the survey in that particular.

The charge, that this survey is extended too far inland, has been met so often and refuted that it seems hardly necessary again to notice it, put forward as it generally is for the sake of bringing the operations of the coast survey nearer to the mere nautical standard. The advantage in rapidity and accuracy in causing the main triangulation to follow the shortest lines of the coast, and to occupy, where practicable, a range of hills in the interior, is admitted by all those who comprehend the subject. The longer the exterior sides, the larger those from head-land to head-land will be; the less the labor, the greater the progress and the greater the accuracy of the work. The crossing of the neck from New York to the Delaware, and from the Delaware to the Chesapeake, leaving the outer coast of New Jersey, Delaware, Maryland, and Virginia to the tertiary triangulation checked by the primary, were most important to the economy and precision of the survey. So the occupation of the interior hills of Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine were essential to the rapid progress (and therefore the economy) and to the minute accuracy of the work. The secondary triangulation and topography are carried no further inland than is necessary for navigation and defence. A chart, which does not show the navigator the features of the coast which he is approaching, is comparatively valueless, and so universal is this opinion that even in mere nautical surveys the attempt is made to substitute rude sketches of the country for accurate topographical representations. A chart which stops at the shore line fails in the very essentials. For purposes of defence it is essential that the nearest communication by land should be deliniated, and in many cases this will be of great value even to the navigator.

The coast survey maps are carried to the nearest land communication in those parts of the coast, when such communications are not too far in the interior. On those parts of the Southern coast where the communications are chiefly by water, the statistics of the topography show that the proportion of shore line to area surveyed is much increased, attesting that the principle is fully carried out by those engaged in this part of the work, and that the work is not carried unnecessarily inland.

So of the objection that it is carried too far seaward, embracing the Gulf stream, it is equally untenable with the former; for a hydrographic work on the coast of the United States, which would omit the characteristic and peculiar features of its hydrography, would be an absurdity.

19. The vessels used in the coast survey are of two classes; one engaged in the hydrography, and the other used as a means of transportation for the land parties. The vessels used in the hydrography are under the command of naval officers, and the officers (except the captain's clerk) and the men are furnished by the Navy Department. A part of these vessels belong to the survey, having been paid for out of the general appropriations, a part have been transferred from the revenue service, the Quartermaster General's department of the army, and the Navy Department. Of thirteen vessels used by the hydrographic parties during the last year, five were purchased by the Survey, five furnished by the Treasury Department, and three by the Quartermaster's Department. The Navy Department has furnished to the coast survey but four small vessels, and these in such a condition and of such size as to be unsuited to the hydrographic purposes, unless for a temporary use.

The saving to the Government by the transfer of the revenue vessels to the survey, instead of selling them, was shown by my predecessor, in a letter addressed to the Committee on Commerce of the House of Representatives in January, 1849, and transmitted to the Senate, with his report in relation to the expenditures and results of the coast survey. (Exec. Doc. No. 26, Senate, 30th Congress, 2d session.) The annual saving to the revenue marine by the transfer is there stated at $39,000. Similar conclusions were arrived at independently in the War Department, by the quartermaster general, who recommended, after ample experience in the matter, that the vessels which had been used as transports should, as far as practicable, be transferred to the other departments of the Government, where they might be used, instead of being sacrificed at public sale. Two of the largest and most useful steamers, one of which had been much desired for the survey of the Western coast, were transferred to the Navy Department, in the service of which one still remains, the other having been lost near Point Conception.

A statement of the names and number of vessels employed, the cost of repairs, hire, &c., up to the close of 1848, will also be found in a report by my predecessor, in February, 1849. (Exec. Doc. No 27, Senate, 30th Congress, 2d session.)

A vessel which draws more than from nine to eleven feet of water is inadmissible for use on a survey of shoals, and of our coast generally. One drawing six feet is objectionable in many cases. Some parts of the coast require absolutely vessels which do not draw more than from three to five feet, to enable the work to be done readily. Large vessels, then, are entirely inapplicable to this purpose. Even the steamers which we obtained from the revenue service, though made for coasting, have been complained of by some of the hydrographic parties as drawing too much water, and the necessity for light draught steamers has been dwelt upon in different reports by the Superintendent and assistants.

The navy has no sailing vessels, and but two steam vessels, at all adapted to coast survey service. The class of vessels chiefly used in the coast survey are unknown now in the naval service. The revenue cutter Taney was loaned to the Navy Department by the Treasury, for use in its expedition under Lieut. Maury's direction, because there was no vessel deemed suitable which was available.

20. The principles of natural philosophy involved in the construction of an apparatus for the measurement of base lines are altogether beyond the range of ordinary study. It must be adjusted for expansion by heat, not only while the temperature is stationary, but while it is rising and falling, involving some of the subtlest principles of mathematics applied to physics. The construction of it requires that the workman shall be directed by a practical experimental philosopher. The use of it requires the same qualifications. It is no discredit to an army or navy officer to say that in the line of his profession he has had no opportunities of perfecting himself in experimental philosophy. One of the most meritorious officers in the French navy was entirely thrown out of the line of promotion because he preferred to remain ashore and to devote himself to the development of the observation of terrestrial magnetism, which he had collected in his voyages, rather than to go to sea. Seamen may incidentally be philosophers, but a

they become so lose the qualities and habits necessary for command at sea.

The use of field astronomical instruments, the zenith telescope, the zenith sector, and the transit instrument, is foreign to the seaman's profession as it is to the military officer's. Either may learn, but his teaching must be paid for in time and money. The former becomes a landsman when he devotes himself to the occupation; the latter has the advantage in preparation and compatibility of pursuit. The use of geodetic instruments, the theodolite and others, of topographical instruments, the plane table, compass and chain, all belonging to the survey, are beyond the profession of the navy officer.

To execute topography with skill requires the constant devotion of mind, hand, and eye. The water is not the place in which training for this purpose is acquired. To trace curves of levels and represent slopes, to distinguish between the characteristic features and accidents of ground, are gifts which only few trained surveyors possess; and, however elaborate the system of direction, without constant practice success is not to be attained. Compare one of the topographical maps of our coast survey with the rough delineation of hills on the navy charts of Great Britain, or the minute delineations of the maps of Schumacher and Muffling of the Danish and Prussian coast, with the crude representations of the shores of the Chesapeake, or of North or South Carolina, in our nautical surveys. Topography is, as geodesy, a profession. Our work would be inferior to that of enlightened nations generally if executed by nautical men, instead of landsmen, by tyros instead of trained topographers. The whole system of the scales of shade, introduced by the German topographers and perfected in our own coast survey, delineating accurately the slope and features of ground, is unknown to nautical men, and unpractised on any nautical chart made by them in any part of the world.

Geodesy is an application of mathematical principles which [illegible] out of the range of the usual studies in mathematics and natural philosophy. It is a special branch. The elementary books contain only lately some exposition of it, and that in this country, from the impulse given to the science, and the practice by our coast survey. It is no exaggeration to say that no mere nautical man can even read understandingly the formulæ upon which the computation of difference of longitude, difference of latitude, and difference of azimuth are based; and if it were required that an examination should be held for aspirants to this branch of the coast survey, it is certain that the number would be very limited who would present themselves to this ordeal, merely to explain, much less to deduce the formulæ upon which the computations are based. Nor would it be a discredit to the naval man that he was not versed in these things more than to the philosopher that he could not direct the sailing of a ship.

A coast survey without these requisites would bring discredit upon our country. Better to attempt none than one which would, in reproducing the methods and practices of a century ago, make us the laughing-stock of the civilized world.

There is no single operation in the office of the coast survey which is not beyond the sphere of the nautical man professionally, except merely the reduction of the nautical chart. The reduction of all the land work is made by methods with which he is entirely unfamiliar, and which are absolutely essential to delineate that work with the degree of minuteness corresponding to its execution. The very preparation of the drawing board and of the paper on which the delineation is to be made, involves physical principles which in the course of his profession he has not examined, and yet which are essen- [illegible] ess. To ascertain that the importance of these [illegible] verrated, let any one visit, as I have done, the [illegible] ffice, and see the time, attention, and investi- [illegible] ave been bestowed upon them, and the results [illegible] n obtained. If the land work were not exe- [illegible] ed by such methods, the accuracy attainable [illegible] execution and reduction, would be far from [illegible] rt requiring special devotion. Few officers [illegible] this. On our own survey even, the nautical charts are chiefly drawn by civilians, who are now for th most part actually paid from the funds of the coast survey. Many naval officers who are considered accomplished hydrographers, do not even attempt to execute these reductions. The chiefs of parties themselves consider it no disparagemens that they cannot do the work of trained draughtsmen. It it nevertheless true, that unless the person who directs these reductions is specially trained to it, and has the taste of an artist, the work is inferior in its style and execution. Practice has shown that to make creditable reductions for publication, the direction must be placed with a person specially educated to it. It is a profession apart from that of the nautical man. The course of drawing at West Point forms some men adapted to such a position, but those who have ranked high in the course of drawing desire time and study, and close examination of the work as executed, before being willing to enter upon its direction. To underrate the difficulties of a practical branch is common with those who, knowing nothing of it, would nevertheless undertake its direction.

The whole business of engraving is beyond the profession of the navy officer, and yet he who directs should know at least the general principles of this art. The whole of the processes have been matured at the coast survey office by the experience of the engravers themselves, and the intelligent observation of the assistants in charge of this special part of the work. The result is that the engraving department will bear comparison with the best of Europe, with the French, and with the Prussian. The style of our maps has been praised at home and abroad.

The whole business of printing is beyond the profession of either the army or navy officer. Important improvements have been made in it by the experiments in our coast survey office, and experimental inquiries have prepared the way for further ones still. As an art, this is of course committed to persons regularly brought up to it, but routine will not answer in a work like this. Unless the methods of printing are better than those adopted in foreign charts, the measurements made on different parts of the same sheet of a chart, and in different directions in regard to the edges of the paper, will not be exact.

The entire business of electrotyping belongs to experimental philosophy, and is entirely beyond the profession of either the army or navy officer. It has been perfected in the coast survey office by the labors of philosophers, both workmen and directors. The arrangement and management of the galvanic batteries, of the decomposing troughs, of the plates on which the deposite is made, and of those which are consumed in the process, all require knowledge of physical principles and practice in experiment far beyond the usual range of reading and experimenting in natural philosophy. A process has been obtained which secures the plates from adhesion. It may be said that this could be contrived by others. True, as long as the services of the present able electrotypist could be secured; but without them not. It would, however, be a bad argument for the transfer of a work, which had attained great excellence, that it could be continued mechanically by others. The argument, too, would be fallacious, because, however excellent, there is always room for progresss and greater excellence, and to stereotype a work at any point of progress is to ensure that in ten years it will be behind the science of the day. Now, then, electrotyping is essential to the multiplication of copies of maps and charts from copper plates, saving the enormous expense of engraving over and over again the same plates. Engraving on steel has hitherto been only applied to small objects, and if large steel plates could be made, such as are required for the coast survey maps, the great time required to engrave upon it, and other expensive incidents of the art, would induce a preference of engraving on a soft metal like copper, and copying by the electrotypc process. It has been proved that by this process the time required for the engraving of a map may be reduced in any desired proportion, since a copper plate may be divided into parts, each part be engraved separately, and then the whole may be united, and a plate be derived from them by the electrotype process, in which the greatest accuracy and minuteness can detect no error.

Even in the practice of hydrography there are calls for scientific and experimental knowledge beyond and without the attainments of the naval profession The method of observing, plotting, and reducing current observations; the representation of currents in charts; the reduction and computation of the tidal data of the ordinary kind, and of unusual cases, such as single day tides; the investigation of the character of the bottom, and especially of the minute shells found in the soundings, and characteristic of particular places; the accuracy in different cases in sounding and in tidal observation; the formation of coral reefs and bars, are all of this character. It is a remarkable fact that the sailing directions for entering a harbor or sailing along a coast, might be supposed so strictly nautical that it would not be neglected by the nautical man, and yet while even the chart of a hydrographic reconnoissance in our coast survey is accompanied by sailing directions in the chart, the nautical charts made by our own navy and by that of Great Britain are without them. The mode of representing these results belong rather to the general philosopher than to the nautical man, as the improvements introduced upon our coast survey prove.

There are many scientific problems involved in a geodetic survey, which involve the highest principles of mathematics in their discussion.

The determination of the length of an arc of the meridian is one of the first of these. From Nantucket, in Massachusetts, to Blue Mountain, in Maine, an arc of not less than $3\frac{1}{2}$ degrees will be measured by the triangulation of the coast survey. From a station near the head of the Chesapeake to Portsmouth, Virginia, an arc of $2\frac{3}{4}$ degrees will be measured. These measures are of the first importance in determining the figure of the earth. The southern arc is of special value, since the results of Mason and Dixon seemed to show irregularities in the figure of the earth, which have caused their measurements to be questioned. An entirely new mode of measurement has been proposed, and will be used in the operation of the coast survey.

The measurement of an arc of the parallel along the coast of the Gulf of Mexico is also a matter of importance. This assumes new interest to us from the facility afforded by the telegraph for determining the differences of longitude between two places, which, if connected by a chain of triangles, would give at once the length of the arc of the parallel.

The investigations necessary in carrying out a system of telegraphic differences of longitude are beyond the usual calls made upon sea officers. The whole subject of communicating signals by telegraph is involved in it, and of the delay which occurs in the transmission of the telegraphic signals.

The local attraction of the plumb line, found to exist at near stations, and involving consequences both in the theory and practice of the work, is a problem which requires for its solution the closest training in mathematics and physics. It has been admitted even by foreign authority that our coast survey has taken the lead in this subject. This question affects both the determinations of latitude and azimuth.

The theory of the tides, so ably handled by Whewell, Lubbock, and Airy, and the important tables resulting from a discussion of observations, finds its place in the same grade of research. The tides of the Gulf of Mexico, which have been observed for many years in detached surveys and by nautical men, have received their first solution from the Superintendent of the coast survey, and tables for the prediction of these tides will result from his investigations, important both in a scientific and practical point of view. No nautical man has attempted with success this subject of the single day tides of the Gulf of Mexico.

The thorough investigation, such as has been made in the coast survey, with the instruments adapted to the purpose of measuring temperatures below the surface, involves scientific principles of the same class.

The thorough discussion of observations made, requires the application of the highest principles of mathematics. The peculiar importance of this subject has been expressly dwelt upon by Baron Humboldt and M. Arago, in the letters to which I have before referred.

These constitute a part only of the problems which it is desirable, for the credit of our country, for the success of the survey, and for the practical use to be made of them, should be dealt with by the mathematician and experimental philosopher.

21. If qualification to execute a particular work was the test, according to which it was to be assigned to this or that bureau of a department, or to this or that department of the Government, the greatest confusion would reign.

The army officers educated at West Point would grasp at the Observatory, the nautical almanac, the casting and testing of cannon, the construction of dry docks, the machinery of navy yards, the construction and regulation of the lighthouses, the surveys of the public lands, the building of custom-houses, of all public buildings. They would aspire to be the constructors of the ships and ordnance of the navy, of steam engines for national vessels. The corps of topographical engineers would not only execute the land work of the coast survey, but its hydrography; and with the strongest reason, since on the lakes they execute both land and water work, and have made some of the best hydrographic charts of the harbors of our coast. Why have an army and a naval ordnance corps, when the army can do both, saving the personnel of nearly a whole corps?

The Treasury Department, on behalf of the coast survey, would claim the Observatory and nautical almanac from the Navy, the land surveys from the Interior, and through its revenue officers would undertake to man and sail the vessels of the navy.

The Navy would grasp at the revenue service, the coast survey, the lighthouse arrangements.

In conclusion, I am convinced that on the score of accuracy, rapidity, and economy of execution, as well as of efficiency of organization, the coast survey should be left in the Treasury Department, where it is now by law placed, in which all the provisions for progress are to be found, and under which the men of science of the coun[illegible] and its military and naval officers, are effectively combi[illegible] knowledge, skill, and industry to execute [illegible] manner worthy of the country, and of the [illegible] we live. Respectfully submitted.

THO.

Secretary of

Hon. W. R. King, *President of the Sena*

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